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Bacteremia associated with tunneled dialysis catheters: Comparison of two treatment strategies

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Bacteremia associated with tunneled dialysis catheters: Comparison of two treatment strategies.

Background. Tunneled dialysis catheters are often used for temporary vascular access in hemodialysis patients, but are complicated by frequent systemic infections. The treatment of bacteremia associated with infected tunneled catheters requires both antibiotic therapy and catheter replacement. We compared the outcomes of two treatment strategies for catheter-associated bacteremia: exchange of the existing catheter with a new one over a guidewire versus catheter removal with delayed replacement.

Methods. We retrospectively analyzed the outcomes of all cases of tunneled dialysis catheter-associated bacteremia during a two-year period. The infection-free survival time of the subsequent catheter was evaluated in two groups of patients: group A (31 catheters), exchange of the existing infected catheter with a new catheter over a guidewire, and group B (38 catheters), removal of the infected catheter followed by delayed catheter replacement 3 to 10 days later. Patients in both groups received three weeks of systemic antibiotic therapy. Cox proportional hazard models were used to evaluate the factors predictive of infection-free survival time of the replacement catheter.

Results. On univariate proportional hazard regression analysis, the infection-free survival time of the replacement catheter was similar for groups A and B ($P = 0.72$), whereas the hazard of infection was significantly greater for patients with hypoalbuminemia (serum albumin < 3.5 g/dL), as compared with patients with a normal serum albumin (hazard ratio 2.81, 95% CI, 1.21, 6.53, $P = 0.016$). The infection-free survival time was not affected by patient age, sex, diabetic status, or type of organism (gram-positive coccus vs. gram-negative rod).

Conclusions. The infection-free survival time associated with the subsequent catheter is similar for the two treatment strategies. However, exchanging the catheter for a new one over a guidewire minimizes the number of separate procedures required by the patient. Hypoalbuminemia is the major risk factor for recurrent bacteremia in the replacement catheter.

Key words: hemodialysis, dialysis catheter, infection, hypoalbuminemia, vascular access.

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Tunneled dialysis catheters placed in a central vein are used frequently in hemodialysis patients as a temporary vascular access until an arteriovenous (AV) fistula or a polyfluoroethylene (PTFE) graft is ready to use [1]. In addition, dialysis catheters are used as a permanent vascular access in some patients who have exhausted all options for placement of a fistula or graft. A large proportion of hemodialysis patients in the United States dialyze through a catheter at any time. In a recent survey, nearly 20% of the prevalent patients required a dialysis catheter for vascular access [2]. As compared with fistulas and grafts, tunneled dialysis catheters offer the advantage of ease of placement and the ability to be used immediately for dialysis. However, they suffer from several disadvantages, including poor blood flow [3], frequent thrombosis and infection [3–5], risk of central vein stenosis [6–8], and limited longevity [5, 9].

Infections are the most serious complication of tunneled dialysis catheters. The frequency of catheter-associated bacteremia has been about two to four per 1000 patient-days in a number of studies, equivalent to 0.7 to 1.5 per catheter year [5, 10–12]. In contrast, the frequency of infections is approximately 0.2 per patient-year for AV grafts and 0.05 per patient-year for AV fistulas [13]. Moreover, catheter-associated bacteremia often results in serious systemic infections, including endocarditis, osteomyelitis, epidural abscess, septic arthritis, and even death [11]. Treatment of catheter-associated bacteremia with systemic antibiotics without catheter removal is not usually effective. Only 22 to 32% of tunneled catheters can be salvaged without catheter removal [5, 10, 11, 14]. Moreover, attempting to salvage the infected catheter with antibiotics alone incurs the risk of serious systemic complications, including endocarditis and epidural abscess [15]. On the other hand, the removal of the dialysis catheter creates a short-term vascular access hardship until a new catheter can be placed, frequently necessitating the insertion of one or more femoral dialysis catheters and requiring utilization of an inpatient dialysis unit.

Several recent observational studies have reported that exchanging infected dialysis catheters over a guidewire, in combination with systemic antibiotics, results in successful resolution of the infection [12, 16, 17]. Unfortunately, none of these studies reported a concurrent control group for comparison of the outcomes.

The present study retrospectively analyzed the outcomes of the replacement catheters following all episodes of dialysis catheter-associated bacteremia during a two-year period. We compared two treatment strategies at our institution: exchange of the infected catheter with a new one over a guidewire versus removal of the infected catheter followed by delayed placement of a new catheter 3 to 10 days later. Both patient groups received systemic antibiotics for three weeks. We used prospective, computerized records [18] to track the catheter events.

METHODS

Patient population

The University of Alabama at Birmingham (UAB) provides chronic dialysis to approximately 350 in-center hemodialysis patients. About 15% of the prevalent patients dialyze with tunneled dialysis catheters. The demographics of the patients dialyzing with catheters are as follows: 26% of the patients are age 65 or older; 51% of the patients are female; 84% of the patients are black, and 16% are white; 41% of the patients have diabetes. All patient hospitalizations, surgical procedures, and radiologic procedures are done at UAB Hospital. The vast majority of dialysis catheter procedures are performed by interventional radiology.

Dialysis catheter placement and management

Double-lumen cuffed dialysis catheters were placed by one of four experienced interventional radiologists. All catheters were placed through the internal jugular vein using ultrasound guidance. The tip of the catheter was positioned in the right atrium using fluoroscopy, with the distal end tunneled through the subcutaneous tissue in the anterior chest wall and the Dacron cuff positioned within the tunnel. Aseptic techniques were used by the dialysis nurses to access the catheters for hemodialysis. Catheter thrombosis was treated by instilling 5000 units of urokinase into each lumen [4]. When this maneuver failed to re-establish patency, the catheter was replaced over a guidewire with a new dialysis catheter, utilizing the same subcutaneous tunnel.

Management of dialysis catheter-associated bacteremia

Infection was suspected whenever patients with a dialysis catheter developed fevers or chills, in the absence of an alternative source of infection. Treatment with empiric broad spectrum antibiotics (vancomycin and gentamicin) was initiated immediately after obtaining blood cultures from a peripheral vein. Patients with clinical sepsis (some combination of high fever, persistent shaking chills, or hypotension) were hospitalized for further management, whereas those with milder symptoms (low grade fever and stable blood pressure) were managed as outpatients. The dialysis catheter was removed promptly (within 24 to 48 h) if there was an exit site infection, severe sepsis (persistent shaking chills or hypotension) in spite of antibiotics, or persistent fever 48 hours after the initiation of antibiotic therapy. In the remaining cases of catheter-associated bacteremia, one of two treatment strategies was followed, at the discretion of the nephrologist. The first strategy (group A) consisted of replacing the infected dialysis catheter with a new one over a guidewire within a few days once the bacteremia was clinically resolved (absence of fever or chills). Documentation of negative blood cultures following antibiotic administration was not required prior to catheter replacement. The second strategy (group B) consisted of removal of the dialysis catheter within 1 to 2 days of the onset of clinical symptoms and placement of a new tunneled dialysis catheter 3 to 10 days later. In the interim, these patients were dialyzed with a femoral dialysis catheter. Patients in both groups A and B received three weeks of systemic antibiotic therapy, which was tailored to the culture and sensitivities reported. The differences in the strategies selected by the individual nephrologists were largely due to their subjective impressions regarding the severity of clinical sepsis.

Data collection

A full-time dialysis access coordinator scheduled all of the dialysis access procedures and maintained a computerized record of all procedures performed [18]. Consent for review of the patients' medical records for research purposes was obtained from the UAB Institutional Review Board. Removal of infected dialysis catheters was performed by either interventional radiology or access surgery, whereas exchange of infected catheters or placement of new catheters was performed by one of four experienced interventional radiologists. We identified all cases of dialysis catheter-associated bacteremia occurring during the two-year period between January 1, 1997, and December 31, 1998. If a patient had more than one episode of catheter-associated bacteremia during the study period, only the first infection was included in the analysis. We excluded cases in which a replacement catheter was not inserted within 10 days of removal of the infected catheter. (In most instances, this was due to having a permanent access ready to use, persistent fever after catheter removal, or patient death.) The following demographic and clinical information was collected for each patient: age, sex, race, diabetic status, serum albumin, and the organism grown from the blood

Table 1. Baseline clinical features of patients with catheter-associated bacteremia

	Group A	Group B	*P* value	All catheters
Number of catheters	31	38		69
Age (mean ± SD)	52 ± 16	52 ± 16		52 ± 16
Age >65 years	8 (26%)	10 (26%)	0.96	18 (26%)
Age <65 years	23 (74%)	28 (74%)		51 (74%)
Sex				
Male	13 (42%)	21 (55%)	0.27	34 (49%)
Female	18 (58%)	17 (45%)		35 (51%)
Race				
Black	26 (84%)	32 (84%)	0.97	58 (84%)
White	5 (16%)	6 (16%)		11 (16%)
Diabetes				
Yes	11 (35%)	17 (45%)	0.44	28 (41%)
No	20 (65%)	21 (55%)		41 (59%)
Type of organism				
Gram-positive coccus	22 (71%)	22 (58%)	0.26	44 (64%)
Gram-negative rod	9 (29%)	16 (42%)		25 (36%)
Serum albumin[a]				
<3.0 m/dL	11 (38%)	9 (25%)	0.48	20 (31%)
3.0–3.9 m/dL	15 (52%)	21 (58%)		36 (55%)
>4.0 m/dL	3 (10%)	6 (17%)		9 (14%)
Serious complications				
Yes	7 (23%)	6 (16%)	0.47	13 (19%)
No	24 (77%)	32 (84%)		56 (81%)
Outcome of the replacement catheter				
Infection	16 (52%)	16 (42%)	0.86	32 (46%)
Elective removal	5 (16%)	7 (18%)		12 (17%)
Malfunction	8 (26%)	11 (29%)		19 (28%)
Death	2 (6%)	4 (10%)		6 (9%)

Groups are defined as: Group A, exchange of catheter over guidewire; Group B, removal of catheter with delayed placement of new catheter.
[a]Values missing in four cases

cultures. Finally, each patient's medical records was reviewed to evaluate for serious complications associated with catheter-associated bacteremia.

We then evaluated the infection-free survival time of the replacement catheter. The longevity of each replacement catheter (groups A and B) was calculated as the number of days from catheter placement (or exchange) and catheter removal. The indication for catheter removal was categorized as infection, malfunction (thrombosis or poor flow), or elective (permanent vascular access ready to use). When urokinase was unsuccessful in restoring blood flow, the patient was referred to interventional radiology for an elective exchange. We also determined the organism responsible for the infections in the replacement catheters.

Statistical analysis

Descriptive statistics were used to summarize the sample data. The time from catheter replacement (exchange or delayed replacement) until recurrent infection was calculated. Survival analysis techniques were used to model infection-free survival time. Patients whose catheter malfunctioned was electively removed (permanent vascular access ready to use) or who died with a functioning catheter were considered censored. Univariate Cox proportional hazard models were fit. Multivariable Cox proportional hazard models allowed for the evaluation of the significance of several independent variables in the presence of each other. Hazard ratios and the associated 95% confidence intervals were computed. Survival distributions were plotted using the Kaplan–Meier method.

RESULTS

We analyzed the outcomes of all cases of dialysis catheter-associated bacteremia during the two-year period from January 1, 1997, to December 31, 1998. After excluding patients who did not receive a replacement catheter within 10 days of catheter removal, we were left with 69 cases of documented catheter-associated bacteremia. The age, sex, racial distribution, and frequency of diabetes among this group of patients (Table 1) were similar to that in the prevalent dialysis population at UAB. Approximately two thirds of the patients were infected with a gram-positive organism (mostly *Staph aureus* or *Staph epi*), and the remainder had gram-negative infections. Serious complications occurred in 19% of all episodes of catheter-associated bacteremia. These included endocarditis (2 patients), septic arthritis (3), septic emboli to the brain (1), and severe sepsis requiring hospitalization in the intensive care unit (7).

The patients were classified retrospectively into two groups according to the clinical management of the catheter. Group A patients had the infected catheter replaced

Table 2. Univariate proportional hazard regression analysis of clinical factors as predictors of infection-free catheter survival

Variable	Hazard ratio	95% C.I.	*P* value
Treatment group	0.88	(0.43, 1.79)	0.72
Serum albumin (<3.5 vs. ≥3.5 g/dL)	2.81	(1.21, 6.53)	0.016
Age	1.00	(0.98, 1.02)	0.74
Sex	1.49	(0.73, 3.05)	0.27
Race	0.64	(0.22, 1.84)	0.41
Diabetic status	1.72	(0.83, 3.58)	0.15
Type of organism	1.60	(0.69, 3.73)	0.28

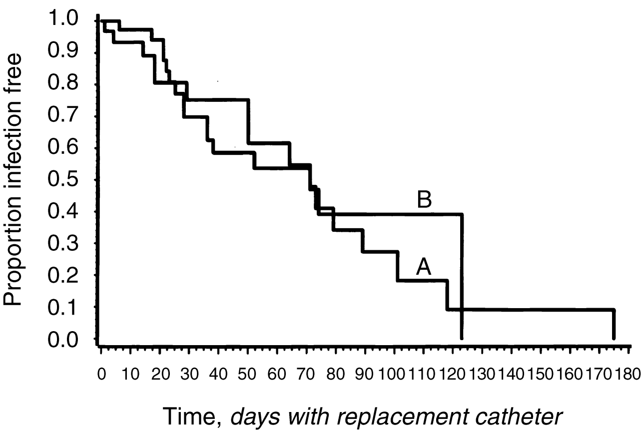

Fig. 1. Life-table analysis (Kaplan–Meier survival curves) for infection-free survival of the replacement catheter in patients whose dialysis catheter was replaced with one of two strategies (group A, replacement over a guidewire; group B, removal of the catheter with delayed replacement 3 to 10 days later, $P = 0.72$).

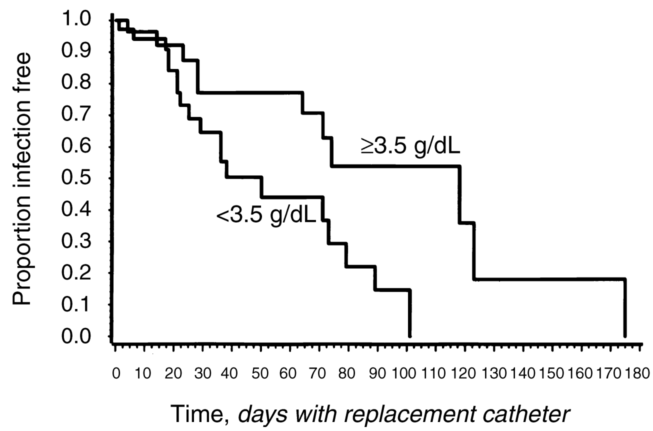

Fig. 2. Life-table analysis (Kaplan–Meier survival curves) for infection-free survival of the replacement catheter in patients with hypoalbuminemia (serum albumin < 3.5 g/dL) versus patients with a normal serum albumin, $P = 0.016$).

with a new one over a guidewire. Group B patients had their infected dialysis catheter removed, with delayed placement of a new catheter 3 to 10 days later. Patients in both treatment groups were treated with three weeks of systemic antibiotics. The patients in both groups were similar to each other in terms of age, sex and race distribution, frequency of diabetes, type of infective organism, and severity of infection, as inferred from the frequency of serious complications (Table 1).

Of the 69 replacement dialysis catheters, 32 had to be removed because of a second infection (Table 1). In addition, 19 catheters were replaced because of malfunction (thrombosis or poor flow). Twelve were removed electively because the patient had a fistula or graft that was ready to use, and six were patent and uninfected at the time of patient death or date of study analysis. On univariate proportional hazard regression analysis of infection-free catheter survival time, there was no significant difference between patients in groups A and B (Table 2 and Fig. 1). Patients with hypoalbuminemia (serum albumin < 3.5 g/dL) had a higher hazard of a second episode of catheter-associated bacteremia than patients with a normal serum albumin (Table 2 and Fig. 2). The infection-free survival time was not significantly affected by patient age, sex, race, diabetic status, or type of infective organism (Table 2). Finally, using multivariable stepwise proportional hazard regression analysis, only low serum albumin and male sex had increased hazard of catheter infection (this was true whether serum albumin was treated as a categorical or continuous variable).

Among patients whose initial infection was with a gram-positive organism, the second infection was with another gram-positive organism in 88% of the cases. In contrast, following a gram-negative, catheter-associated bacteremia, the next infection was equally likely to be with a gram-positive or gram-negative organism.

DISCUSSION

We observed a high frequency of infections of the replacement dialysis catheter following an initial episode of catheter-associated bacteremia. Although this was not a randomized study, the patients in groups A and B were closely matched in terms of their clinical characteristics (Table 1). The infection-free survival time was similar whether the initial dialysis catheter was exchanged with a new one over a guidewire (group A) or whether it was removed with delayed placement of a new catheter 3 to 10 days later (group B). The former strategy requires a single, relatively brief procedure by interventional radiology, without an interruption of the outpatient hemodialysis schedule. In contrast, the second strategy involves two separate radiologic procedures, at least one femoral dialysis catheter placement, and at least one dialysis session in the inpatient dialysis unit. Moreover, the removal of an infected catheter carries the risk of losing a potential vascular access site as a result of occlusion of a central vein. Thus, from the perspective of cost-benefit analysis, as well as patient convenience, the strategy of catheter exchange is clearly preferable in those patients who qualify.

The inverse relationship between the risk of recurrent infection in the replacement catheter and serum albumin was striking. Previous studies have found an association of hypoalbuminemia with systemic infection in hemodialysis patients [13]. The mechanism by which hypoalbuminemia predisposes to recurrent infection remains to be elucidated.

The frequency of serious complications following catheter-associated bacteremia was remarkably high, but consistent with a previous report [11]. At our institution, 14% of the prevalent hemodialysis population were using a tunneled dialysis catheter for vascular access. A recent survey by the Centers for Disease Control reported that 17.5% of patients in the United States were dialyzing with a dialysis catheter [2]. The ongoing Dialysis Outcomes and Practice Patterns Study (DOPPS) found that 62% of new U.S. hemodialysis patients and 31% of prevalent patients were using a dialysis catheter, rates that are substantially higher than those observed in European hemodialysis patients (personal communication from David Goodkin, M.D., Amgen Corporation, Thousand Oaks, CA, USA). Extrapolating our experience to the U.S. dialysis population suggests the occurrence of a very large number of catheter-associated infections in the United States, resulting in serious morbidity in many of these patients. The current study suggests that a strategy of elective catheter exchange in patients with catheter-associated bacteremia is an acceptable alternative to catheter removal with delayed placement of a new catheter. Moreover, the catheter exchange strategy should reduce the number of procedures, decrease the cost, and minimize the disruption of the outpatient hemodialysis schedule.

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